CHAPTER VIII.

FIRING ATTACHMENTS AND GAS-EXPELLING DEVICES.

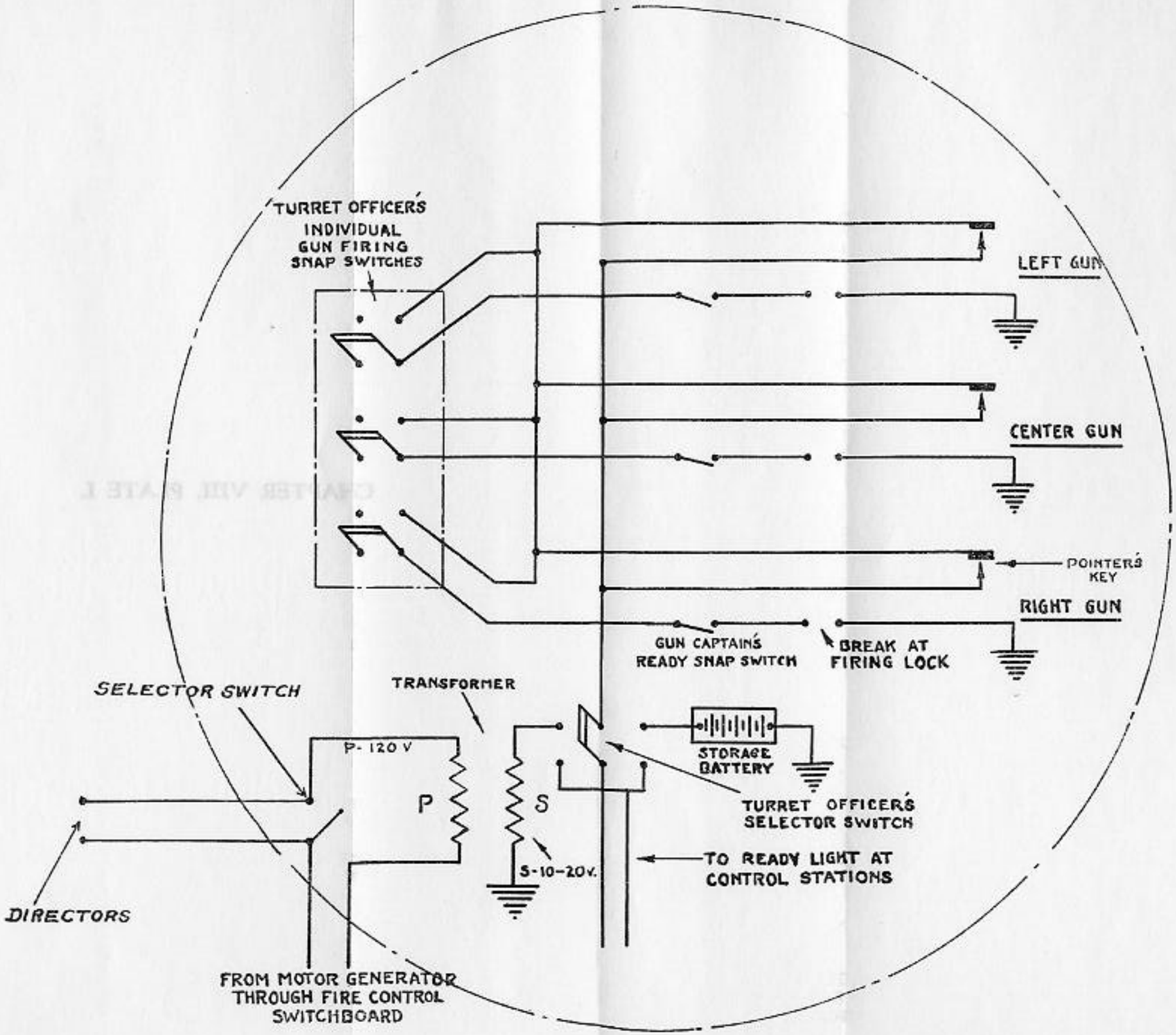
801. In U. S. naval guns the term *firing mechanism* is used to designate that part of the breech mechanism which directly explodes the primer and thus fires the gun. The *firing attachments* comprise those appliances fitted to the gun and mount, which put the firing mechanism in operation. The lock lanyard, electric firing battery, wires, terminals, and firing key are attachments.

802. Electric firing for large guns is the primary method of fire, percussion firing being used only as an alternative. Electric primers shorten the *firing interval*, or the time that elapses between the instant the gun pointer wills to fire and the instant the projectile leaves the muzzle. This interval, which on the average is three-tenths of a second, has two factors: (1) The *personal factor* (which is much the greater), depending on the pointer's quickness of co-ordinating mind and muscle, and (2) the time consumed by the travel of the projectile along the bore and by the mechanical action of the firing devices.

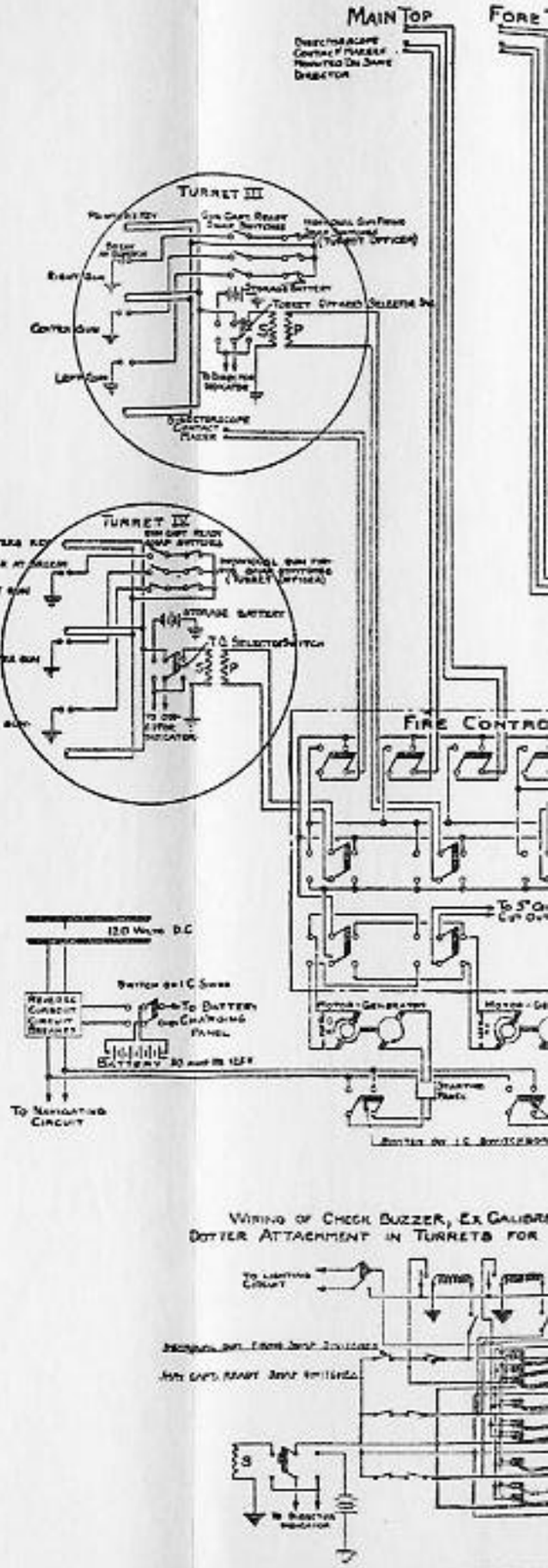
803. Current for electric firing is furnished by motor generators or by storage batteries, connections being made so that either may be used. The motor generators for this purpose, usually two in number, are located in an interior communication room of the ship, and take direct current from the ship's circuit. They deliver alternating current at 125 volts to the fire-control switchboard, where the various units of the battery are cut in or out in accordance with orders from the fire-control officer. Alternating current has several advantages over direct current for gun firing circuits. The principal advantage is that the presence of a transformer in each turret or gun circuit prevents a ground or short circuit in one turret or gun from putting the entire firing circuit out of commission.

804. Firing circuit for turret guns.—The wiring diagram for the firing circuit of turret guns on a battleship is shown on Plate I. It will be seen that direct current for the motor end of the motor generators can be taken either from the ship's mains or from a storage battery discharging at the rate of 50 ampere hours, with a voltage of 125.

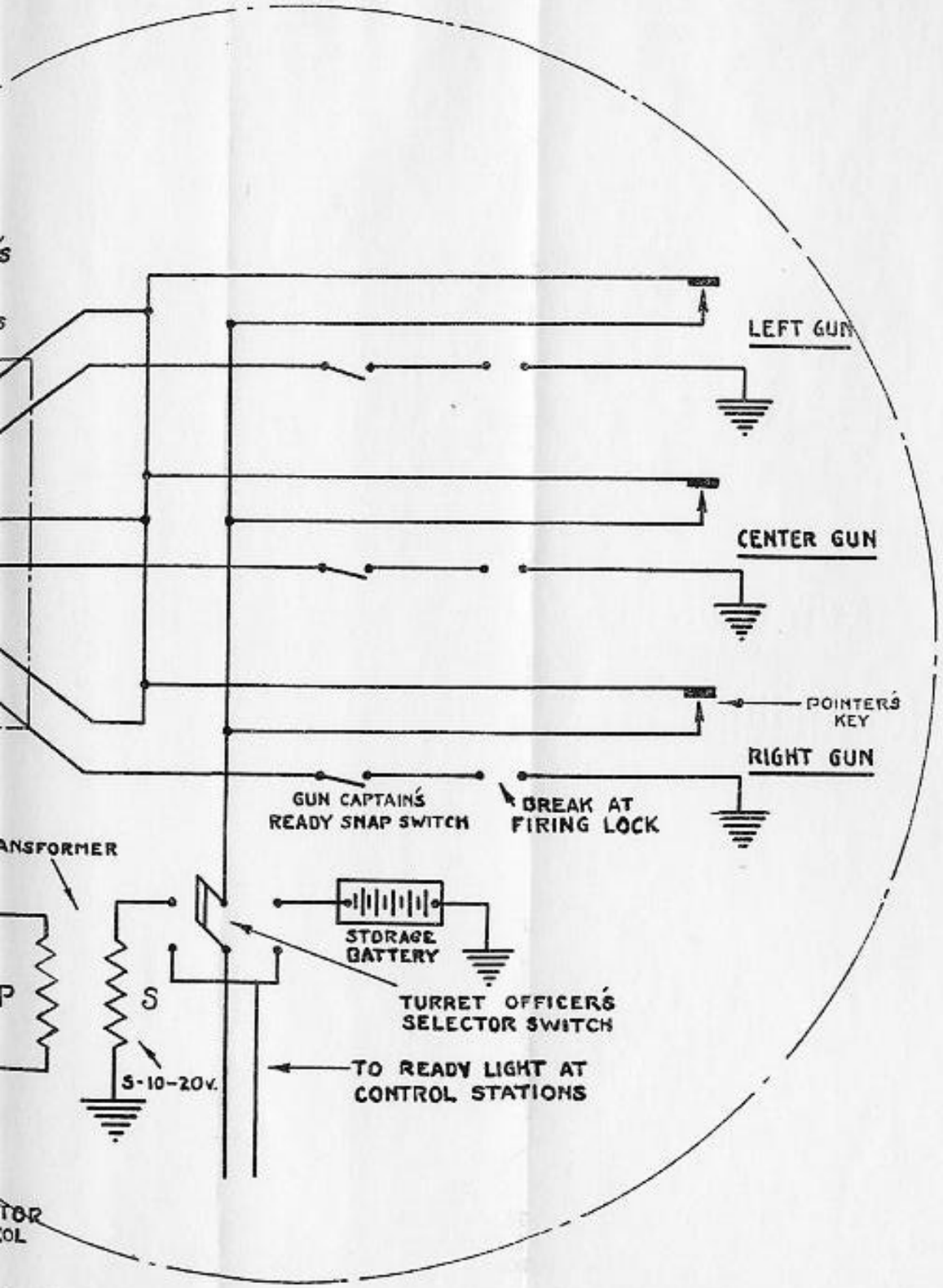
The motor generators serve merely to convert direct current into alternating current at the same voltage. The latter is led to the fire-control switchboard, which is shown to carry four cut-out switches,



ENLARGED WIRING DIAGRAM FOR THE FIRING CIRCUITS OF THE THREE GUNS OF ONE TURRET ONLY.



WIRING DIAGRAM FOR FIRING



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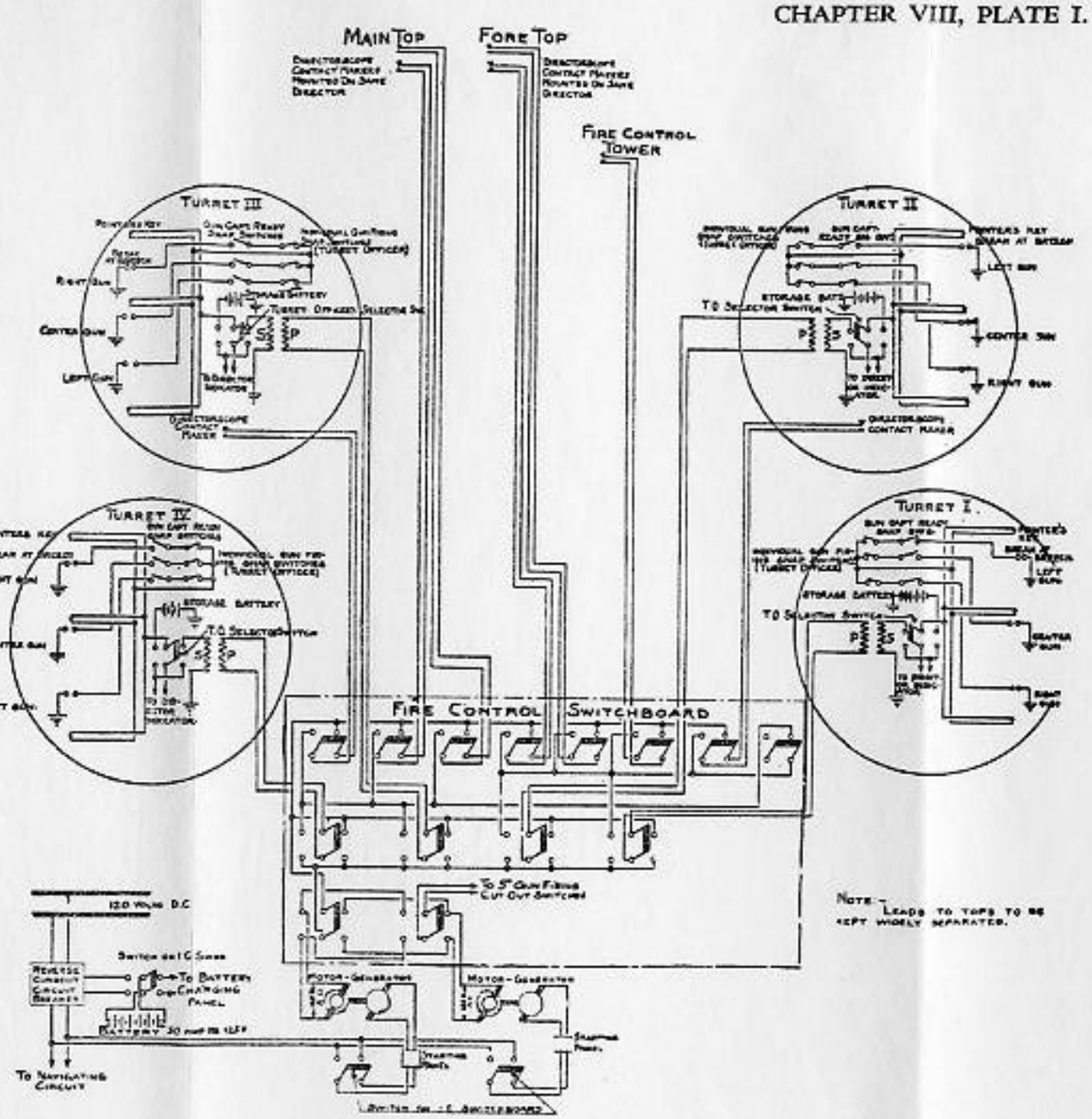
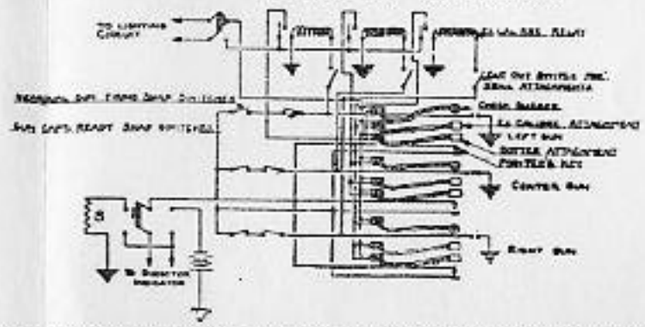


Wiring of Check Buzzer, Ex Calibre, and Dotter Attachment in Turrets for Drill Purposes.



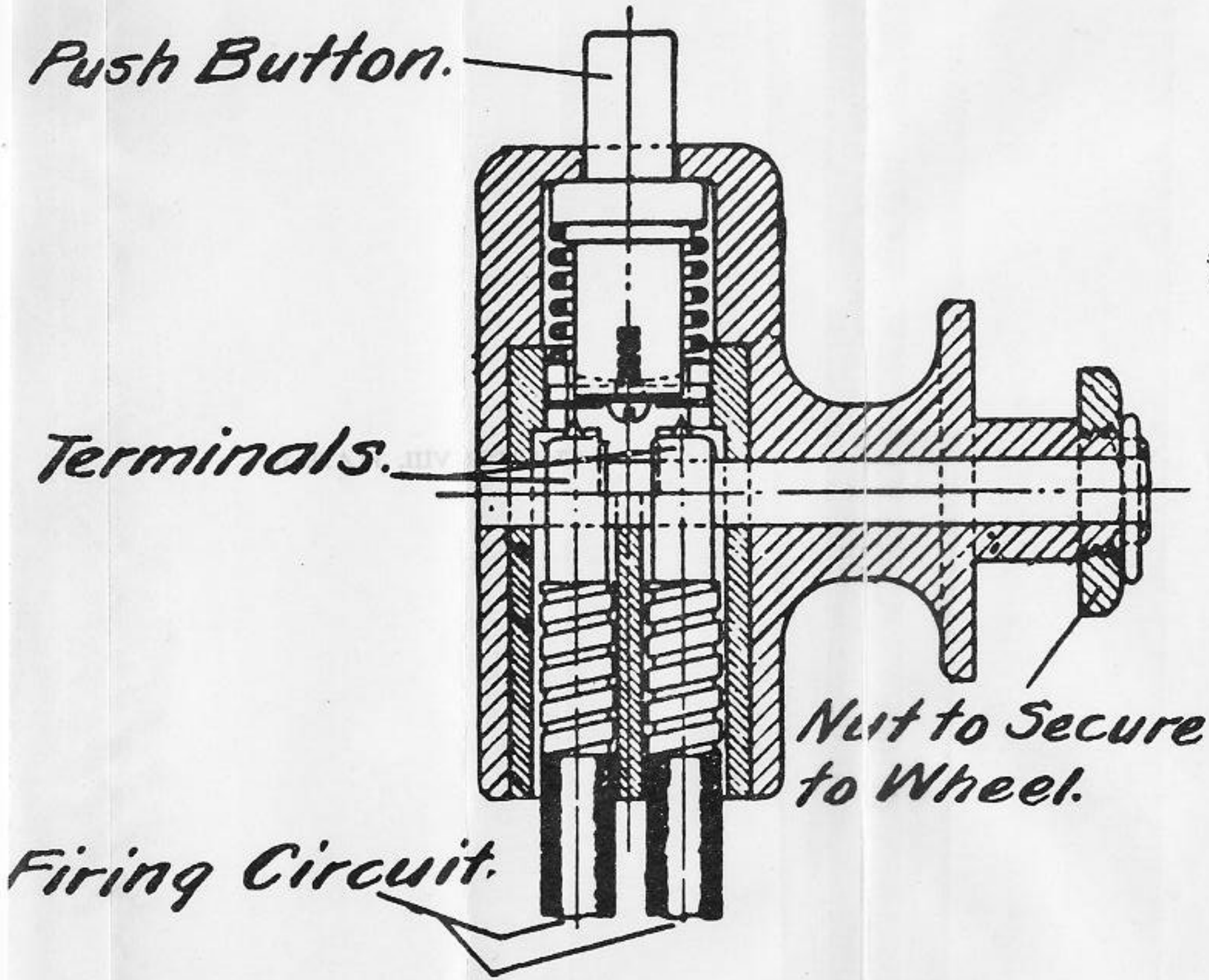
WIRING DIAGRAM FOR FIRING CIRCUIT FOR TURRET GUNS.

one for each of the four turrets. By closing these switches to the right, current is delivered directly to the primary coil of a transformer located in each turret. There the voltage is stepped down to 20 volts alternating current at the terminals, which is ample for firing the primers in the guns.

805. Located in the turret officer's booth in the turret is a selector switch for either director fire or local fire; when this switch is closed for local fire the current is completed to the primary coil of the turret transformer. There also is a selector switch whereby current for firing can be taken either from the secondary of the transformer or, in case of failure of the motor generator, from a local storage battery in the turret. This is a separate battery from that mentioned in Art. 804, which may be used to supply the motor generator. Following the diagram, it will be seen that the path of the current leads from this switch to the pointer's firing key at each gun, thence, individually for each gun, to the turret officer's snap switch (which is closed unless he wishes to cut out a gun from firing), then to the gun captain's ready switch (which is closed as soon as the gun is loaded and primed), thence to the terminals at the breech of the gun (which make contact as soon as the breech is closed and locked), from this point to the primer bridge, and thence to ground. It is apparent, therefore, that as soon as the gun is loaded, primed, and ready, the only break in the circuit is the pointer's key which is closed when the pointer's sight is on the target and the firing signal is sounding. All guns of the turret may be fired from any one of the gun firing keys, the pointer being designated as the firing pointer.

806. The portion of the firing circuit described so far is sufficient to enable the guns to be fired by the pointers. This method or system of firing, known as "pointer fire," was the only one in use until about 1914. Since that time, however, "director fire" has been introduced under which the guns are laid to a predetermined angle of elevation, and the actual sighting and firing is done from a station located usually aloft. The remainder of the firing circuit shown on Plate I covers this director feature, and consists of the necessary switches and leads to the various gun directors installed on the ship.

As will be seen from the diagram, directors are located in the fire-control tower, the foretop, the maintop, plot, and in high turrets Nos. 2 and 3. By proper manipulation of switches on the fire-control switchboard, any one of these directors can be made to control all turrets; or the control may be divided between two of them, the foretop director, for instance, being used for turrets Nos. 1 and 2 and, the maintop director for turrets Nos. 3 and 4.



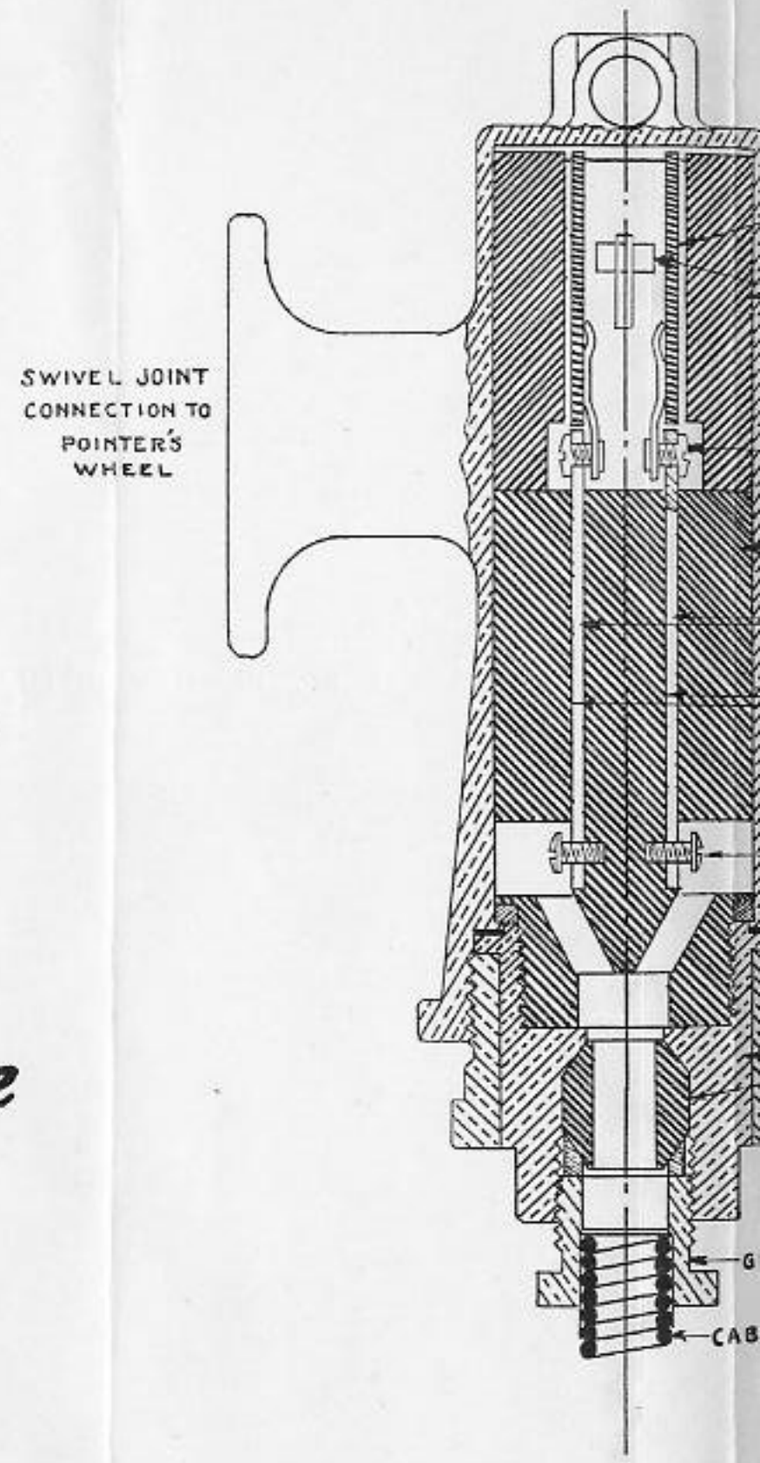
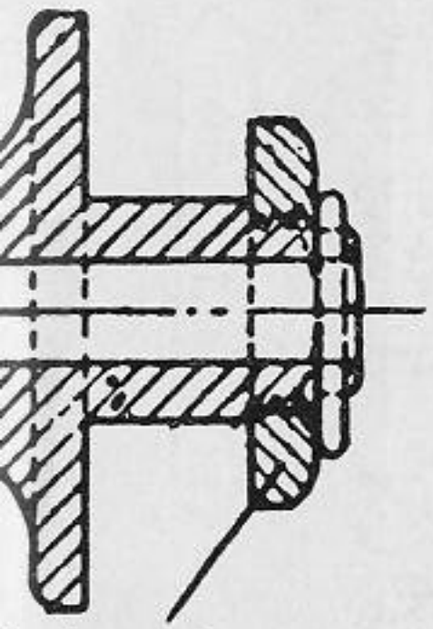


FIG. 1.—PUSH-BUTTON TYPE OF FIRING-HANDLE USED ON TWO-HANDED DRIVE-WHEELS



to Secure
Wheel.

WHEELS

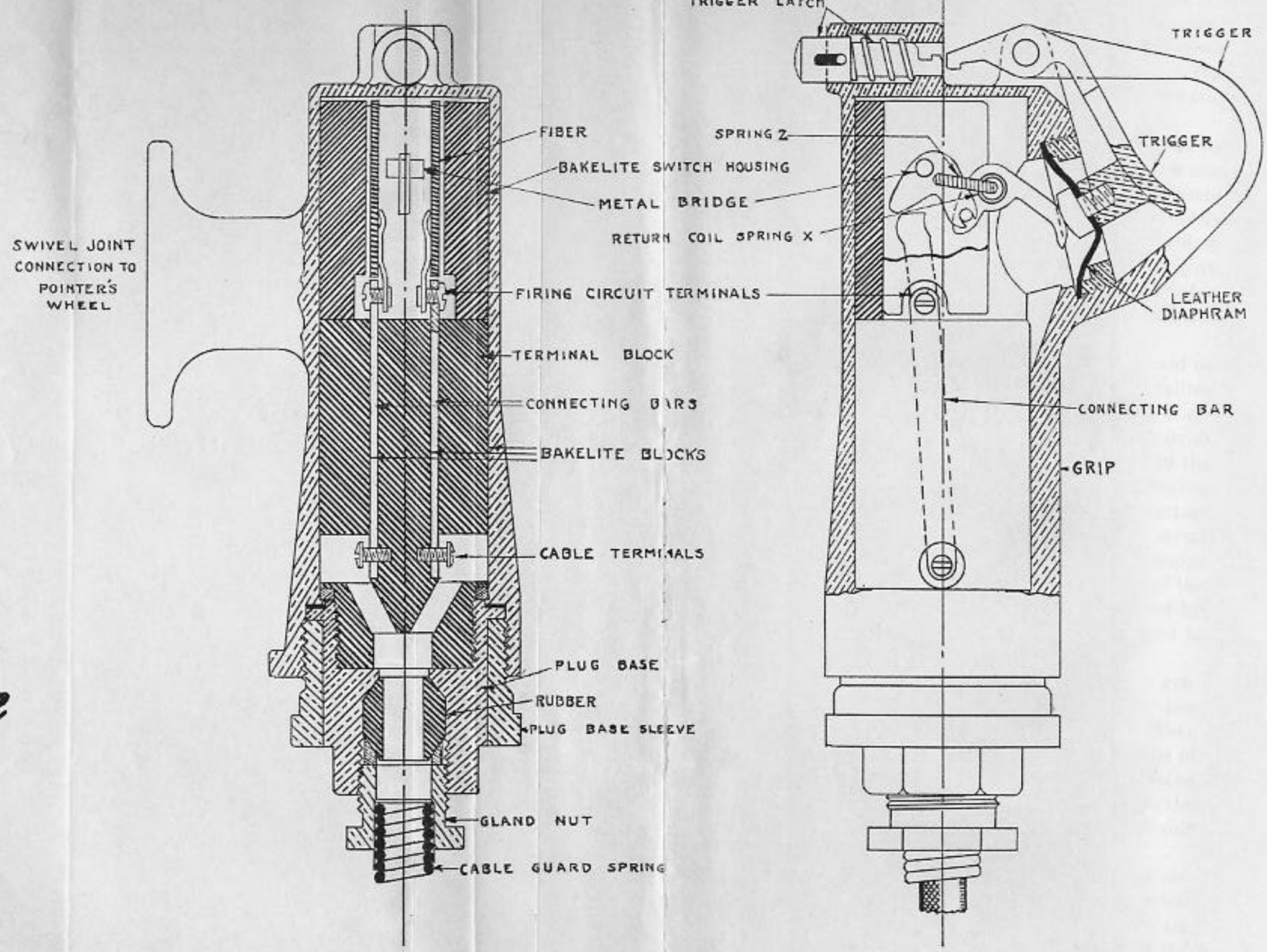
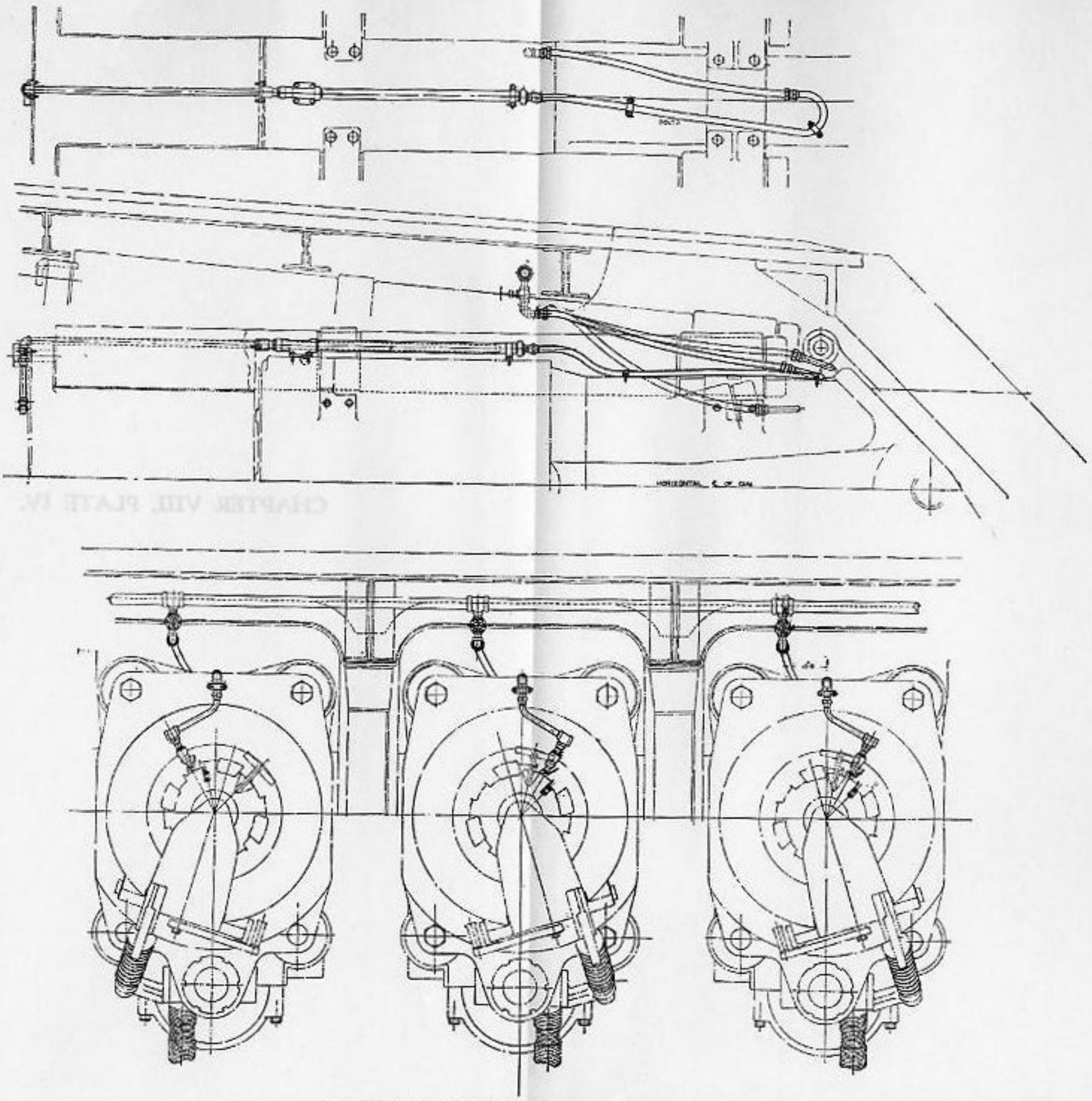


FIG. 2.—MARK XVI FIRING KEY



GAS EJECTOR SYSTEM FOR TURRET GUNS.

When director fire is being used, the four turret switches on the fire-control switchboard are thrown to the left. The firing pointers' keys in the turrets are closed when the guns are laid, and held in that position, so that, as soon as the guns are loaded and ready, the only break in the circuit is the firing key at the director. It is customary to have a firing pointer in addition to the elevating pointer in each turret. The firing pointer, observing an elevation indicator and with a separate firing key on another lead, keeps the circuit closed if the guns are loaded and the pointers of the gun elevation indicator remain matched. The guns in the turrets, all laid to the desired angle of elevation, fire in salvo as the director key is closed.

When the turret officer's selector switch is thrown either for battery or motor generator, it closes at the same time the ready-light circuit, lighting the ready lights in plotting room and control stations, to indicate that the turret is ready to fire. This is a 110-volt circuit entirely independent of the firing circuit, but the throw of the double-pole selector switch closes one break in each circuit.

It will be noted that both the foretop and the maintop are provided with double leads to the director. This is due to their exposed position. The extra leads provide a stand-by in case one circuit should be cut.

807. Plate I shows also the wiring in the turret for dotter gear, sub-caliber, and other drill purposes. For simplicity and clarity these circuits have been omitted from the drawing of each turret. No special description of this material is required, since the diagram indicates clearly the various connections.

808. The firing circuit for broadside guns, together with the lighting circuit, is shown in Fig. 801, which represents a 5-inch, 51-caliber gun and mount with firing attachments.

In order better to follow the various leads, a diagrammatic layout of the circuit is shown below the mount. For simplicity the switching arrangements of the interior-communication and the secondary-battery switchboards have been omitted from the diagrammatic sketch. Plate I shows the connections on the fire-control switchboard for the lead to the primary windings of the secondary-battery transformers. It will be seen that current for firing may be taken either from the secondary winding of the transformer or, in case of failure of the motor generator, from a local battery, the transfer switch being thrown as desired. From this switch, the path of the current leads to the pointer's firing key, then to the breech of the gun where a break in the circuit occurs in the firing lock until the breech is fully closed and locked, and thence through the primer bridge and primer wall to ground. The other end of the circuit is shown grounded at the transformer and battery.

809. Branching from the lead from battery is shown the lighting circuit, which serves to illuminate the cross wires in the pointer's and trainer's telescopes as well as the sight scales and the training indicator in the base of the gun mount. It is apparent from the diagram that current for lighting is taken only from the battery. The lamps, which are small and of low voltage, are grounded on one side in order to complete the circuit back to the grounded battery terminal.

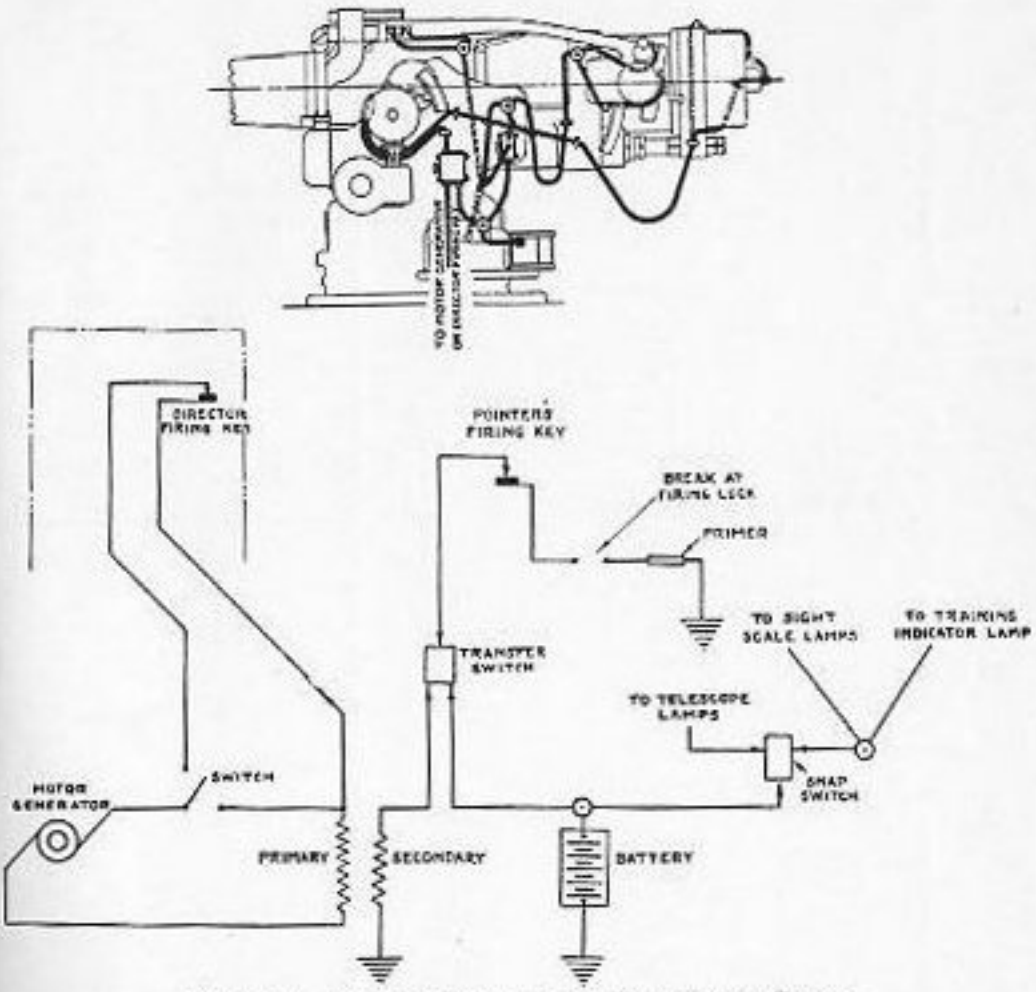


FIG. 801.—FIRING CIRCUIT FOR BROADSIDE GUNS.

810. For director firing of broadside guns, additional leads extend to the director station. There the director is located, provided with a key for firing all guns of a group or broadside. These leads are indicated for convenience in Fig. 801 which shows the firing circuit of one gun only. Actually the complete wiring diagram would resemble somewhat the diagram for turret guns shown on Plate I, where one director can be cut in to fire a number of guns.

Referring to Fig. 801, by closing *downward* the switch shown in the lead from the motor generator, the director is cut out, and current is

provided at the gun for "pointer fire." Closing the switch *upward* cuts in the director and puts the circuit in readiness for "director fire." When the latter method of firing is used it, of course, becomes necessary to close the pointer's firing key at the gun and maintain it in that position when the gun is in all respects ready to fire, so that the only break in the circuit will be at the director firing key.

811. In all electric firing chief dependence is placed on the motor generator. The battery is used as a stand-by source of current in case of failure in the motor-generator line. For director fire it is apparent that the battery cannot be utilized at all, since its use is confined solely to the gun or turret where it is located, whereas director fire involves the firing of several guns in salvo, all from the same source of current.

812. Firing keys.—In the discussion of firing circuits above, reference has been made to the pointer's firing key, and to the director firing key.

Figure 1, Plate II, shows the form of firing handle formerly used on two-hand drive wheels, such as were provided for 5-inch, 51-caliber guns. The firing handle is simply a push button carrying on its lower end a metal bridge to close the gap between the insulated firing circuit terminals. In its normal position, the metal bridge is held clear of the terminals by means of the spiral spring shown. Pressing the push button serves to compress this spring and bring the metal bridge into contact with the terminals. It will be noted that the mounting of the metal bridge at the bottom of the push button is such as will allow the bridge to adjust its position to accommodate itself for unequal lengths of the terminals of the firing circuit. This type of key has been displaced by the Mark XVI firing key, but it may be occasionally encountered in service.

Figure 2, Plate II, shows the handwheel grip firing key now in general use for main, broadside, and anti-aircraft batteries. The same key is adapted to the form of the pistol grip for use on the directors. When the trigger is squeezed, the metal bridge is forced down by means of the lever system shown, thus closing the gap between the insulated firing circuit terminals. When pressure on the trigger is released, the metal bridge is thrown out of contact with the terminals and the circuit broken by action of the two springs X and Z.

813. Care of electric firing attachments.—All batteries, firing circuits, and firing locks should be frequently tested. Batteries are tested for voltage and specific gravity of the electrolyte. Firing circuits are tested for resistances from the switchboard to the grounded leg of the primary winding of the transformer (both direct and via the directors), from the grounded leg of the secondary of the transformer to the firing

locks, and from the binding posts of the latter to the firing pin points. On all tests on open circuit, the resistances should not be less than one megohm. On closed circuit, they should not exceed one ohm. Due to the action of grease the insulation material of firing locks has a short life and requires frequent renewal. The insulation, if possible, should be kept free of grease.

It is of the utmost importance to keep firing locks and firing attachments in efficient condition. The failure of the firing circuit of a gun impairs, to a great extent, the offensive power of the ship. The faults most frequently found are broken wires and grease or other foreign matter in the connections. Plugs should be well secured to prevent them from being jarred loose by gunfire. Wiring should be properly covered with insulating material to prevent the possibility of short circuits. Electric primer failures are generally due to poor contacts or poor insulation in the firing locks. The primer seats and primers especially should be kept clean and free of grease. The surest test of electric firing circuits is the firing of primers.

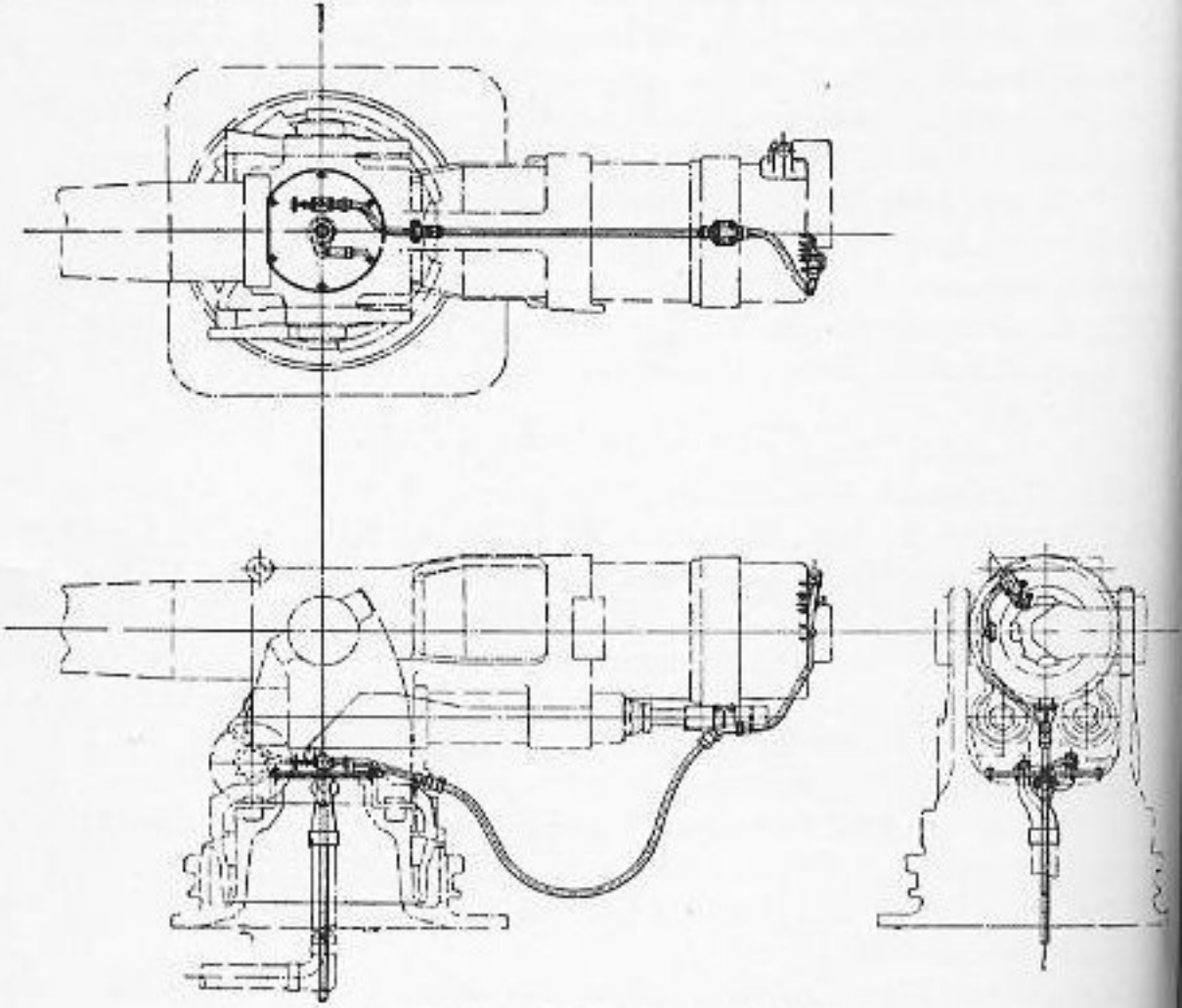
GAS-EXPELLING APPARATUS.

814. Flarebacks.—The smokeless powder used in the United States Navy leaves in the bore, after firing, an inflammable gas (carbon monoxide) which sometimes becomes ignited on opening the breech plug, causing what is called a flareback. With bag guns this flareback is very dangerous, since the powder charges may be ignited by it in loading, as happened with disastrous results in the after 12-inch turret of the U.S.S. *Missouri* on April 13, 1904.

815. Gas-expelling device.—To guard against flarebacks, an air blast device is now fitted to all bag guns to blow out through the muzzle the gases remaining in the gun after firing. Plate III shows the device fitted to a 5-inch gun, and Plate IV shows a similar one for 14-inch and 16-inch turret guns.

Referring to Plate III, air at about 150 pounds pressure is brought from an *accumulator* through a brass pipe extending up through the mount. A swivel joint in the lower part of the mount (turret) permits the gun (turret) to be trained without rupturing the air line. Directly beneath the gun is a stop valve by means of which the air pressure can be placed on the gun or shut off as desired. Beyond this valve extends a section of flexible metal hose, of length sufficient to allow for the recoil of the gun. The after end of this hose is coupled to a section of copper piping, which in turn leads to the *gas-ejector valve* located on the breech of the gun. Figure 802 shows this valve. Instead of a bight of flexible tubing, broadside guns are frequently fitted with a tele-

CHAPTER VIII, PLATE III.



GAS EJECTOR FOR BROADSIDE MOUNT.

scoping air line, the pipe section attached to the gun telescoping in and out of the pipe section attached to the slide.

816. Operation.—The operation of the gas-ejector valve can be readily understood from the figure. The valve seats downward, being held against its seat by a spiral spring and by the air pressure in the line. Against the bottom of the valve rests one end of the valve plunger, the other end being in contact with the cam-shaped valve trigger. There is a cam plate on the breech plug, so located that the first motion of rotation of the plug in opening brings this plate against the valve trigger, revolving it beyond the dead center and thus pushing the valve

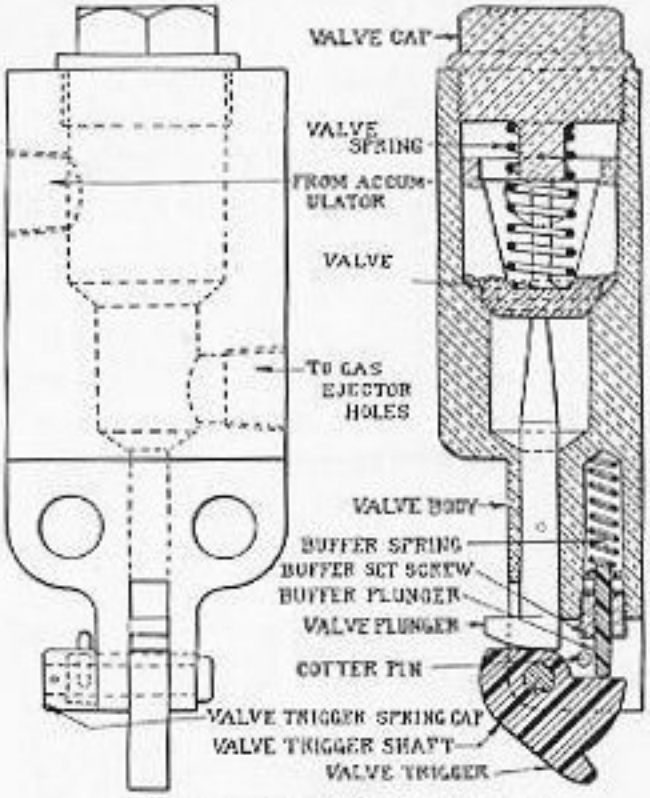


FIG. 802.—GAS-EJECTOR VALVE.

plunger upward and unseating the valve and leaving it open until closed by hand. This allows the air to rush past the valve to an annular passage cut between the screw-box liner and the jacket, and thence through equally spaced holes leading to the screw box. As soon, therefore, as the breech plug has been withdrawn sufficiently to unseat the gas check, air is forced through the muzzle of the gun, taking with it the gases lingering in the bore. When the breech is fully opened, and the bore is seen to be clear, a member of the gun crew touches a lever on the valve-trigger shaft, which trips the valve and closes it, thus shutting off the air. During firing, air pressure is kept turned on and maintained on the piping up to the gas-ejector valve.

817. Below the armored decks, automatic closing valves are installed in the air lines to the guns mounted in exposed parts of the ship, such as the upper decks. Should these unprotected (by armor) lines be pierced, the resulting escape of air would diminish quickly the pressure in the accumulators. These valves are so adjusted that the fall of pressure due to opening the breech of a gun does not affect them, but an abnormal fall, such as that caused by a rupture of the air line, causes them to close immediately.

818. The gas-ejector system for turret guns, shown on Plate IV, is similar to that described for broadside guns. Air from the accumulators is led to a point overhead near the roof of the turret, where an athwartship pipe distributes it to the guns. Each gun is fitted with a telescoping air line, extending to the breech where the gas-ejector valve is located. For both broadside and turret guns, the original design for maintaining the integrity of the air line during recoil was to connect the terminal of the air system on the breech with that on the slide by means of a section of flexible metal hose. The later and more usual practice for both broadside and turret guns is to fit telescoping air lines in place of the flexible metal hose. Whichever method is used between gun and slide to provide the necessary flexibility during recoil, it is also necessary to install a flexible metal hose or a flexible ball and socket coupling in the air line between the carriage and the slide to provide the required flexibility during elevation.

The gas ejector system is shown attached to the gun in Plates XII–XX, Chapter VII.

819. Air pressure in turrets.—It is customary to close the openings to the turret and maintain the turret chamber under an air pressure above atmospheric from the turret's ventilating system during firing. This is done as an auxiliary to the gas-expelling device, but never replaces it.